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Assessment of market risk in banking as one of the risk pillars in enterprise risk management

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Assessment of Market Risk in Banking as one of the Risk Pillars of Enterprise Risk Management

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Abstract

The global financial crisis of 2007-2008 uncovered the weakness of the risk management in the banking sector. Failure of the banking risk management was due to the unforeseen risks not accounted for in banks' risk management systems, along with weak supervisory monitoring. As a result, Basel Accords had undergone a series of improvement to stress the importance of looking at different risks in an integrated approach, which marked the beginning of a new era for risk management. Banks started to move towards implementing a holistic approach in managing risk, a dynamic approach, which is Enterprise Risk Management (ERM). ERM is managing risks of an entity under a holistic approach instead of the current silo approach. Assessing risk under the umbrella of ERM ensures that banks are measuring risks using all possible approaches to optimize their economic capital and hold the correct required regulatory capital[1]. Moreover, it captures the interdependence between risks, which enhances risk measures. The financial crisis highlighted the importance of market risk and how it interacts with other risks facing financial institutions. Market risk is the losses incurred in on and off-balance sheet items affected by changes in market prices, such as, interest rates and foreign exchange. This paper objective is to measure market risk as a standalone risk using different approaches of both traditional Value at Risk (VaR) and Expected Shortfall (ES) for banks in Europe, Asia and Africa regions to calculate the banks required regulatory capital according to Basel using Value at Risk (VaR) and Expected Shortfall (ES). Finally, the results would aid each region's banks in determining its exposure to market risk. These results should be used as one of the components of the ERM approach to calculate the aggregate risk exposure after integration with other risks.

[1] Regulatory Capital is the level of capital set as provision for each level of a certain type of risk taken by the bank as a hedge. Regulatory capital is set by the responsible Central Bank for each region depending on the market (Elizalde & Repullo, 2007)

Introduction

After the 2007-2008 financial crisis along with the current financial globalization and the rapid development of Fintech, financial institutions can no longer use silo approach in assessing the risks they are facing. Globalization is paving the way for the whole world to be connected through trade and exchange of services. Consequently, risk is being shared and exchanged throughout and cannot be looked at through a silo approach. Spillovers shocks are taking place in different regions, which had been the case in 2007-2008 financial crisis. These spillovers affect the global financial market, which in return reshape the risk management concept across banks. The source of the crisis was the mortgage market breakdown that had affected investors, both private and governmental, throughout the countries and resulted in significant losses. Prior to the crisis, banks had typically studied their market risk through a historical Value-at-Risk (VaR) and stress testing models. Post crisis, banks realized that the latter risk management systems had blind spots, which affected their predictions and led to the collapse of the market. Hence, Basel Accords intervened and imposed a new risk measurement system, which is the Expected Shortfall (ES).

In 1985, the Committee of Sponsoring Organizations of the Treadway Commission (COSO) was founded to support the National Commission of Financial Reporting (NCFR). COSO define ERM as "a process, effected by an entity's board of directors, management and other personnel, applied in strategy setting and across the enterprise, designed to identify potential events that may affect the entity, and manage risk to be within its risk appetite, to provide reasonable assurance regarding the achievement of entity objectives". ERM enhances the banks' performance and prevent loss of resources, as a result, it achieves the targeted profitability levels desired by a bank. Also, ERM ensures that the management implements effective risk and financial reporting along with compliance with new regulations and laws. This results in improved reputational level and continuous upgrade of the risk management system in place to be aligned with the international best practices (COSO, 2004).

Since market risk is an inherent factor in the risks facing commercial banks, such as credit, interest rate, operational and liquidity risks. This paper will assess market risk regulatory capital according to Basel regulations. The paper structure is divided into four parts. First, literature review

discussing market risk and ERM. Second, data and empirical work discussing the data used to construct VaR and ES to measure market risk. The third and fourth sections will be results and conclusion, respectively.

Literature Review

ERM approach enable banks to manage risk under a holistic approach instead of the traditional silo one. This holistic approach entails analyzing different risks facing a bank in parallel to capture the interdependence between risks to estimate the aggregate risk profile of each bank (Soliman & Adam, 2017). Different studies on ERM confirm the necessity and importance for all financial and non-financial sectors to apply it. ERM has been found to have a positive effect on reducing earnings volatility determined by banks' different assets, which is crucial to determine the return for a bank (Gatzert & Martin, 2015). Hoyt and Liebenberg (2011) measured firm value using Tobin Q measure[2] before and after ERM implementation and identified a causal effect between ERM and increase in firm value. According to COSO (2004), ERM encompasses the following, enhance risk response decisions, align risk appetite and strategy, identify and manage multiple and cross-enterprise risks, improve deployment of capital, reduce operational surprises and losses, and seize new opportunities available in the market that suits the bank risk profile. Therefore, ERM leads to a more efficient capital allocation, achievement of optimal capital structure decisions, and better risk management decisions (Grace, Leverty, Phillips, & Shimpi , 2015). Therefore, ERM implementation leads to an increase in economic value added (EVA) and market value added (Shad & Lai, 2015). To sum, ERM approach is beneficial for banks as it can decrease direct and indirect costs under all circumstances, especially in times of distress and proposes an integrated picture to select investment opportunities taking all risks under consideration (Florio & Leoni , 2017).

ERM in financial institutions, including commercial banks and insurance companies, focus on the integration of different risks. Typically, these risks are credit risk, liquidity risk, market risk, interest rate risk, operational risk, reputational risk, compliance risk and strategic risk (Adu-Gyamfi, 2016). A series of working papers had shed light on the importance of market risk and how it is intrinsically related to credit risk, liquidity risk and other risks faced by banks as mentioned in Bank of International Settlement (BIS) report (BIS, 2009). Basel (2019), define market risk as " as the risk of losses in on and off-balance-sheet positions arising from movements in market prices. The risks subject to this requirement are, the risks pertaining to interest rate related instruments and equities in the trading book and foreign exchange risk and commodities risk throughout the

[2] Tobin Q measure is the total market value of the firm divided by its total assets. This ratio is developed by James Tobin who is a Nobel Laureate in economics.

bank. Market risk is the risk arising from movements in market prices affecting on and off-balance sheet positions (EBA).

Measuring market risk is crucial as it is affects banks' balance sheet heavily through its assets. When crises occur, asset values would affect heavily the bank's shareholders and creditors preferences forcing the bank to sell them (Acharya, Engle, & Pierret, 2014). For example, interest rate risk is an essential component of the credit and liquidity risk. Interest rates affect both sides of the balance sheet in terms of deposits and loans and can create interest rate gaps affecting banks' current and future cash flow values. (Milanova, 2010). In addition, changes in the values of banks' assets like loans and securities caused by market changes in interest rates affect the probability of default generating credit risk and affecting the value of the bank (Hartmann, 2010). Drehman, Sorenson and Stringa (2010), developed a stress testing model that showed that the re-pricing characteristics of trading book positions and interaction of market and credit risks are crucial for the valuation of banks' total risk. Therefore, in assessing market risk it proves that there are diversification benefits to the banks' trading book, which accordingly reduces the total risk. this shows that implementing ERM is an efficient approach to capture diversification benefits arising from interdependence between different risks.

As a result, Basel Accords require banks to hold enough capital measured by capital adequacy ratios taking into consideration the weight of risk embedded in each asset. ERM proposes strategies to ensure complying to these regulatory requirements by managing the risk position and integrating them under all the conditions to improve profitability by reorganizing the held assets through risk and return using risk adjusted return on capital as mandated by Basel (McKinsey & Company, 2013). Regulatory capital is identified through risk-return relationships through risk measures.

Value-at-Risk (VaR) is the most famous tool to measure market risk. It is well recognized by Basel and they recommend its use in banks to capture regulatory capital (Basel Committee, 2004). VaR is the potential loss on a market position or portfolio under specific tenor (O'Brien & Szersze´n, 2017). VaR had been the most widely used model for banks since 1993, yet a recent change was proposed by Basel III to using Expected Shortfall (ES). VaR analysis implies that risk is randomly distributed not correlated (Whitehead, 2011; Chen, 2014). In laymans terms, VaR relies on historical data using normal distribution to predict expected loss. For example, an investor investing $1Mn on an index fund tracking S&P 500, their expected loss will report a

VaR of $23.3k. The latter means that using normally distributed returns with this investor at a standard deviation of 1%, can lose $23.3k or more on this investment (Chen, 2014).

Post the financial crisis, the disadvantages of VaR had been shed light on heavily and was decided by the Basel Accord to switch to Expected Shortfall (ES). ES is an expanded version of the VaR, a transformative of the VaR (Zeigal, 2013). ES can be described as conditional VaR or the expected beyond the limit calculated by VaR which means that it accounts for all the losses beyond the VaR calculations (Chen, 2014). ES measures the riskiness of a position by considering both the size and the likelihood of losses above a certain confidence level. The Committee has agreed to use a 97.5% ES for the internal models-based approach and has also used that approach to calibrate capital requirements under the revised market risk standardized approach (Chen, 2014).

The shift to ES by Basel had been sought because VaR was found out to present inaccurate results in distressed periods, which was proved after the financial crisis. VaR can overstate the entire portfolio in relation to its components and understate the bank-wide level risk when measuring portfolio of risks or assets affected by market risk by a bank (Chen, 2014). In addition, VaR's credibility had been questioned as it does not have a sub-additive[3] feature and consequently is not coherent. In 2016, Basel Committee decided to replace VaR by ES driven by VaR's different shortcomings. First, VaR had incentivized banks to take on tail risk which is the risk of extreme market losses since it has a low probability under normal market conditions. In crises, VaR does not capture risk of market illiquidity as witnessed in 2008 when banks were unable to exit or hedge positions in a short time frame resulting in substantial losses. Moreover, VaR metrics do not factor in credit risk accurately in the event of credit rating downgrade of issuers of tradeable investments which can lead to undercapitalized exposures in the banking books (Basel Committee on Banking Supervision, 2019). In summary, Basel Committee accords that shift to ES will ensure better capturing of "tail risk", which will improve capital adequacy during periods of financial market stress (Basel, 2016). Building upon the point that VaR is sub-additive, this means that adopting an ERM initiative will not affect the market risk and its calculations positively leading it to having a higher VaR unlike ES. ES is coherent and not sub-additive which means that it would be affected positively as banks adopt ERM more.

[3] VaR of a portfolio can be higher than the sum of VaRs of individual assets in the portfolio. (Danielsson, Jorgenson, Sarma, G. de Vries, & Samorodnitsky, 2005)

Empirical Work

Following the methodology of Ralf Kellner and Daniel Rosch (2016), this paper will calculate VaR and ES VaR to measure market risk regulatory capital under each model. This methodology was used as it suits the available nature of the data and answer the main research hypothesis, which assumes that measuring market risk of ES is more accurate than traditional VaR during time of financial market crisis. According to both Basel and the international best practices, ES capture tail losses that suits the nature of the market risk and better than that of traditional VaR. To clarify;

H_o: Expected Shortfall (ES) is equal to VaR or less under an (α=0.975)

H_1: Expected Shortfall is higher than VaR under an (α=0.99)

Kellner and Rosch (2013) compared shortfall model (α=0.975) and VaR (α=0.99) with respect to model risk. Kellner and Rosch estimated both models for financial data through using a conditional GARCH model comparing eight innovations' distribution. Their data set consisted of daily negative log returns for three indices (S&P 500, Dax and Nikkei 225) and their respective two exchange rates (USD/EUR and EUR/YEN). Data had been collected from January 2001 till January 2015 and they estimated a rolling window of 1000 days to derive daily risk measure forecasts for day 1001. Their models were based on different distributions. Kellner and Rosch had found that the models which capture heavy tails and/or skewness are the ones that can accurately forecast VaR and ES. In addition to measuring VaR and ES, the authors tested different parameters in order to evaluate the best methods to estimate the risk parameters through estimating parameters for ARMA (1,1) and GARCH (1,1). Ralf and Kellner's results supports this paper's hypothesis which is that risk estimates for Expected Shortfall (α=0.975) is higher than that of VaR (α=0.99) which encourages higher levels of regulatory capital. In addition, they found out that during financial crises, difference between VaR and ES tends to increase proving that ES is more conservative. Ralf and Kellner as well pointed out that these differences can trigger regulatory arbitrage especially in times of financial turmoil.

Moreover, ES encourages holding higher capital than VaR driven by the distributional characteristics of the model.

Data

Thomas Reuters database was used to obtain data on banks from three different regions which are Europe, Asia and Africa. Each list would contain ten medium sized banks and ten large sized banks to have a homogenous sample. Size of medium and large banks would be defined by total asset value that will be obtained from Thomson Reuters Eikon and Data Stream. Period of the data will be spread over 20 years daily to ensure the validity of data. However, since the European Union had been formed in 2001, data had been collected from January 2002 till June 2019.

The data analyzed come from the daily values of 42 banks, of which 20 Asian, 16 European and six African banks. Daily values were retrieved from Thomson Reuters for the time period from January 1st, 2002 to June 26th, 2019. The analysis of each bank separately was preferred in order to minimize the inaccuracy caused by data not being available and manipulating the results. Each region had been divided through asset size into small and large banks as per the tables below. This thesis data consists of daily log returns for 42 banks from three regions with their respective historic volatility, market cap, monthly beta, total assets, daily bid and ask, risk weighted assets and total liabilities.

All the latter had been used to calculate the VaR and ES models using EVIEWS of model α=0.99 and α=0.975 respectively for three regions separately which are discussed as per the below. VaR and ES were calculated through building an ARMA (1,1) and GARCH (1,1) as per the reference paper following the below details. (Kellner & Rosch, Quantifying market risk with Value-at-Risk or Expected Shortfall? - Consequences for capital requirements and model risk, 2016).

In details, VaR measures the risk for a given time t and the return of a given asset is X_t. $VaR^{\alpha}{}_t(X_t)$ is the value at risk for X_t at a certain confidence level $0 \leq \alpha \leq 1$. The α-quantile is the distribution of X_t and it is given by

$$Pr[X_t \leq VaR_t^{\alpha}(X_t)] = F(VaR_t^{\alpha}(X_t)) = \alpha \quad (1)$$

It follows that

$$VaR_t^{\alpha}(X_t) = F_t^{inv}(\alpha) \quad (2)$$

where F^{inv} is the α-quantile of the distribution of X_t.

To allow time varying conditional means and variances of returns, ARMA-GARCH model is applied. The model for the conditional mean is an ARMA (1,1) is given by,

$$X_t = \mu + \emptyset X_{t-1} + \varphi\theta_{t-1} + \theta_t,$$

where θ_t is the error term and μ,$\emptyset$ and φ are constant parameters.

The model for the conditional variance σ^2_t is GARCH (1,1) given by

$$\sigma_t^2 = \omega + \alpha_1\theta_{t-1}^2 + \beta_1\sigma_{t-1}^2 \quad (3)$$

The parameters α_1 and $\beta_1$capture respectively the effect of news and the volatility persistence.

If we assume that follows the normal distribution, the VaR will be given by

$$VaR_{t+1}^{\alpha}\,(X_{t+1}) = \mu_{t+1} + \sigma_{t+1}VaR_{\alpha}(Z_t) \quad (4)$$

where $\mu_{t+1} = \mu + +\emptyset X_t + \varphi\theta_t$, $\sigma_{t+1} = \sqrt{\omega + \alpha_1\theta_t^2 + \beta_1\theta_t^2}$, and $Z_t = \frac{X_{t-}\mu_t}{\sigma_t}$.

Accordingly, ES is given by:

$$ES_{t+1}^{\alpha}\,(X_{t+1}) = \mu_{t+1} + \sigma_{t+1}ES_{\alpha}(Z_t) \quad (5)$$

where

$$ES_{\alpha}\,(Z_t) = \frac{\int_{\alpha}^{1} VaR_{t+1}^{\beta}(Z_{t+1})d\beta}{1-\alpha} \quad (6)$$

Africa

Banks are sorted ascendingly by asset size. Banks that have smaller asset base which starting from Commercial International Bank "CIB" have larger VaR and ES. ES shows higher losses than VaR which confirms the literature that ES is more conservative and would require to hold higher regulatory capital except for one banks, Nedbank Group and Banque De l'Habitat. First, Nedbank group is currently suffering losses and higher beta than the other banks. For Banque De L'Habitat, its VaR and ES are underestimated since calculations did not account for any risk weighted assets. On the contrary, Banque De L'Habitat's VaR and ES should be higher since it had been reporting losses for the last two years.

Bank	Country	Value at Risk	Expected Shortfall
Standard Bank Group	South Africa	-2.1567682%	-2.7145945%
NedBank Group	South Africa	-2.9819956%	-3.7440525%
AttijariWafa Bank	Morroco	-2.1567682%	-2.7145945%
Commercial International Bank “CIB”	Egypt	-3.0087240%	-3.7954901%
Banque De L'Habitat	Tunisia	-2.2635019%	-2.8444502%
Export Development Bank	Egypt	-3.7037762%	-4.6464305%

Asia

Similarly, Asian banks had been sorted ascendingly by asset size showing higher ES than VaR as per the literature. Ping An Bank is the median of the banks showing that the above banks, large banks, have higher VaR and ES than the smaller ones with few exceptions. Below Asian banks show an average VaR of approximately -3.8% and ES of -4.8%. Banks that exceed the average are Sumitomo, Commonwealth, CIMB and Mizuho which had suffered losses over the past few years explaining higher VaR and ES than the average.

Bank	Country	VaR	ES
Bank Central Asia	Indonesia	-3.2311%	-4.0763%
Mitsubishi UFJ Financial Group	Japan	-3.6635%	-4.5911%
Mizuho Financial Group	Japan	-4.2450%	-5.3203%
Sumitomo Mitsui Financial Group,	Japan	-12.9167%	-16.1681%
ICICI Bank	India	-3.9883%	-5.0199%
Shanghai Pudong Development Bank	China	-3.5877%	-4.5080%
China Minsheng Bank	China	-3.4898%	-4.3848%
HOKKOKU Bank	Japan	-2.9467%	-3.6930%
Bank of Iwate	Japan	-3.0320%	-3.8006%
Ping An Bank Co., Ltd	China	-3.8555%	-4.8426%
Yamagata Bank	Japan	-2.7639%	-3.4629%
Bank of Okinawa	Japan	-2.8420%	-3.5674%
Hang Seng Bank	Japan	-2.0907%	-2.6264%
Commonwealth Bank of Australia	Australia	-5.1900%	-6.5033%
Australia and New Zealand Banking Group	Australia	-2.4398%	-3.0624%
Westpac Bank	Australia	-2.3610%	-2.9640%
DBS Bank	Singapore	-2.4181%	-3.0367%
Oversea-Chinese Banking Corp Ltd "OCBC"	Singapore	-3.9338%	-4.9470%
United Overseas Bank.	Singapore	-2.3490%	-2.9499%
CIMB Bank	Thailand	-4.2186%	-5.2799%

Europe

Below are a sample of European banks assorted ascendingly as per the asset size with the majority of their VaR and ES lying around -4.18% and -5.18% respectively. Likewise, ES is more conservative than VaR which requires the banks to hold higher regulatory capital. VaR and ES reflect the banks' operations and their held assets as shown in Greek Attica Bank which has been doing worse than its European counterparts as a consequence of Greece's debt crisis.

Bank v	Country	VaR	ES
BNP Paribas S.A	France	-3.8801%	-4.8649%
Credit Agricole S.A	France	-4.0959%	-5.1340%
Banco Santander S.A	Spain	-3.5014%	-4.3893%
Deutsche Bank S.A	Germany	-4.0461%	-5.0615%
Societe Generale De France	France	-4.3344%	-5.4303%
UniCredit Bank	Italy	-4.4953%	-4.4953%
Intesa San Paolo S.p.A	Italy	-4.1341%	-5.1825%
Commerzbank AG	Germany	-4.7049%	-5.8844%
KBC Group	Belgium	-4.8447%	-6.0778%
Banco Desio S.p.A	Italy	-3.0204%	-3.7865%

CRCAM	France	-2.1959%	-2.7560%
KAS Bank N.V	Netherlands	-3.3234%	-4.1655%
Agram Bank	Croatia	-4.2309%	-5.3085%
Attica Bank	Greece	-8.6083%	-10.7497%
Banca Finnat	Italy	-3.3754%	-4.2338%
Merkur Bank	Germany	-4.2309%	-5.3085%

Conclusion

By measuring Value at Risk (VaR) and Expected Shortfall (ES) for 42 banks spread over three different continents, Europe, Asia and Africa, this paper proves the literature that ES requires banks to hold more regulatory capital than VaR. ES showed more losses than VaR throughout all the continents reflecting each bank's operations, profitability…etc. as shown in the results. As mentioned in the literature, holding higher regulatory capital adds to the banks' costs yet it saves banks more in times of crises such as in 2008. However, choosing ES as a method of determining regulatory capital is more beneficial than VaR since ES is not sub-additive, which means that it accounts for integration is managing the risks of the bank. In conclusion, implementing ERM in banks can save them different costs when using ES more than VaR. Future research might build on this study by calculating ES under ERM and test the diversification benefits. First, ES should be calculated after integrating market risk with liquidity risk. Secondly, ES should be calculated after integrating market and liquidity risks with credit risk and so on and so forth. Afterwards, these ES results with its implications on regulatory capital levels should be reported to top management levels of banks.

References

Committee of Sponsoring Organizations of the Treadway Commission. (2004). *Enterprise Risk Management - Integrated Framework.* COSO.

Acharya, V., Engle, R., & Pierret, D. (2014). Testing macroprudential stress tests: The risk of regulatory risk weights. *Journal of Monetary Economics*, 36-53.

Adu-Gyamfi, M. (2016). The Overview of Risks Facing the International Banking System. *Journal of Insurance and Financial Management*, 107-118.

Basel Committee on Banking Supervision. (2019). *Explanatory Note on the Minimum Capital Requirements for Market Risk.* Bank for International Settlements.

BIS. (2005). *Trading Book Survey: A Summary of Responses.* Bank for International Settlements.

BIS. (2009). *Findings on the Interaction of Market and Credit Risk.* Bank for International Settlements.

BIS. (2012). *Fundamental Review of the Trading Book.* Bank for International Settlements.

Chen, J. M. (2014). Meausring market risk under the Basel accords: VaR, stressed VaR, and expected shortfall. *The IEB International Journal of Finance*, 184-201.

Danielsson, J., Jorgenson, B. N., Sarma, M., G. de Vries, C., & Samorodnitsky, G. (2005). *Subadditivity Re-Examined: the Case for Value-at-Risk.* Cornell University.

Drehmann, M., Sorenson, S., & Stringa, M. (2010). The Integrated Impact of Credit and Interest Rate Risk on Banks: A Dynamic Framework and Stress Testing Application. *Journal of Banking and Finance*, 713-729.

EBA. (n.d.). *Market Risk.* European Banking Authority.

Elizalde, A., & Repullo, R. (2007). Economic and Regulatory Capital in Banking: What Is the Difference? *International Journal of Central Banking*, 87-117.

Florio, C., & Leoni , G. (2017). Enterprise Risk Management and Firm Performance: The Italian Case. *The British Accounting Review*, 56-74.

Gatzert, N., & Martin, M. (2015). Determinants and Value of Enterprise Risk Management: Empirical Evidence From The Literature. *Risk Management and Insurance Review*, 29-53.

Grace, M. F., Leverty, J., Phillips, R. D., & Shimpi , P. (2015). The Value of Investing in Enterprise Risk Management. *The Journal of Risk and Insurance*, 289-316.

Grace., M. F., Leverty, T. J., Phillips, R. D., & Shimpi, P. (2015). The Value of Investing in Enterprise Risk Management. *The Journal of Risk and Insurance*, 289-316.

Hartmann, P. (2010). Interaction of Market and Credit Risk. *Journal of Banking & Finance*, 697-702.

Hoyt, R. E., & Liebenberg, P. A. (2011). The Value of Enterprise Risk Management. *The Journal of Risk and Insurance*, 795-822.

Kellner, R., & Rosch, D. (2013). Quantifying Market Risk with Value-at-Risk or Expected Shortfall? - Consequences for Capital Requirements and Model Risk. *Journal of Economic Dynamics & Control*, 45-63.

Kellner, R., & Rosch, D. (2016). Quantifying market risk with Value-at-Risk or Expected Shortfall? - Consequences for capital requirements and model risk. *Journal of Economic Dynamics & Control*, 45-63.

McKinsey & Company. (2013). *Getting to ERM - A road map for banks and other financial institutions.* Mckinsey & Company .

Milanova, E. (2010). Market Risk Management in Banks - Models for Analysis and Assessment. *Economics and Organization*, 395-410.

O'Brien, J., & Szersze´n, P. J. (2017). An evaluation of banks' measure for market risk before, during and after the financial crisis. *Journal of Banking and Finance*, 215-234.

Pricewaterhouse Coopers LLP. (2012). *Survey on Market Risk.*

Shad, M. K., & Lai, F.-W. (2015). A Conceptual Framework for Enterprise Risk Management Performance Measure through Economic Value Added. *Global Business and Management Research*.

Soliman, A., & Adam, M. (2017). Enterprise Risk Management and Firm Performance: An Integrated Model for the Banking Sector. *Banks and Bank Systems*, 116-123.

Whitehead, C. (2011). Destructive Coordination. *Cornell Law Review* , 341.